FEASIBILITY STUDY
OF
HAMILTON ROAD

BETWEEN
CLARK STATE ROAD AND JOHNSTOWN ROAD

January 27, 2006

Prepared for
The City of Gahanna

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HAMILTON ROAD FEASIBILITY STUDY
CLARK STATE ROAD TO JOHNSTOWN ROAD

TABLE OF CONTENTS

HAMILTON ROAD FEASIBILITY STUDY
CLARK STATE ROAD TO JOHNSTOWN ROAD

LIST OF FIGURES

1. INTRODUCTION

Purpose

The purpose of this study is to determine and recommend the most feasible design for the improvement of the "central section" of Hamilton Road in Gahanna from just south of the intersection of Johnstown Road to and including the intersection of Clark State Road, a distance of approximately 5,000 linear feet (See Figure 1).

Objectives

The study objectives are to analyze all existing planning efforts, existing traffic volumes and related project information, and future design year land use and traffic forecasts to determine the most feasible number of lanes, intersection operations and appropriate design standards for the project.

Background

This "central section" of Hamilton Road is an uncurbed two-lane pavement with one 10 foot travel lane in each direction with narrow gravel berms and generally open drainage. Some locations have grass lawn areas with enclosed pipe drainage adjacent to the narrow berms. A few areas along the east side of the roadway have concrete sidewalks adjacent to the right-of-way line in front of residential subdivisions.

There are eight residential streets which intersect Hamilton Road between Clark State and Johnstown Road, all controlled with stop signs. All these streets but one have existing sidewalks.

The abutting land use along the project area is all residential except for the one thousand foot frontage of the MRDD school on the east side of Hamilton. The residential areas range from single family estate size properties with large setbacks to more typical subdivision home sites to one area of condominium homes. This section of Hamilton Road has no existing street lighting nor does it have existing walking/biking leisure paths.

The posted speed limit throughout this section is 35 MPH except for the 20 MPH school speed zone during restricted hours fronting the MRDD school.

This section of Hamilton Road is included in the city-wide classification of "Principal Arterial" in the City of Gahanna Thoroughfare Plan, adopted by City Council in August, 2001. Principal arterials are the highest or "most important" street category in the City and are recommended by the Plan to be a minimum of five travel lanes. Hamilton Road is the only continuous north-south thoroughfare in the City of Gahanna, and has an interchange with I-270. With the completion

Hamilton Rd. Project Area

FIGURE 1

of construction of the section from south of Johnstown Road to south of Morse Road, this study section will be the only section of Hamilton Road within the City to be two lanes wide. The City Thoroughfare Plan also recommends other design elements appropriate for this classification of arterial.

Recent traffic counts within the study area have recorded Average Daily Traffic volumes of between 16,700 and 18,800 vehicles per day in both directions. These volumes are beyond the normal range of a two-lane street's ability to safely and conveniently handle traffic. Many observations of morning and afternoon peak traffic flows approaching the intersections of Hamilton Road with both Clark State Road and Johnstown Road have confirmed the high level of congestion which exists. Emergency runs within this two-lane section at any time of day have been reported as problematic. The past and present growth in population and land development within Gahanna is expected to continue into the future and will result in increasing travel demand on this arterial street corridor.

2. TRAFFIC VOLUME DATA

Many recent existing traffic volume counts along this and adjacent sections of Hamilton Road were utilized for this study. The count information was provided by City of Gahanna and Mid Ohio Regional Planning Commission (MORPC) records and included both average daily traffic (ADT) volumes and AM and PM peak period turning movements at major intersections. Copies of all volume counts are included in the Appendix.

Historic ADT volumes over the past six years within the study section were analyzed, as well as AM, PM, and midday peak period turning movements at the intersection of Hamilton Road at Clark State Road Other types of traffic volume data analyzed included volume data in the current (2001) Gahanna Thoroughfare Plan, design traffic information from the north section of Hamilton Road (now under construction), and AM and PM peak hour turning movements measured at many of the residential streets intersecting Hamilton Road

A major traffic count was conducted by the City at the intersection of Hamilton Road at Clark State Road in late September, 2004. Traffic volumes in each direction were measured for all 24 hours of the day and all vehicle turning movements at the intersection were recorded at 15 minute intervals during the AM, PM, and noon-time peak hours.

Based on all of the existing traffic volume data, it was determined that the 2004 ADT volume on Hamilton Road between Clark State and US 62 was 18,800 vpd and on Clark State Road east of Hamilton Road was 8,670 vpd (seasonally adjusted). It was also determined that the two critical (highest) hours each weekday were 7-8 AM and 5-6 PM for both Hamilton and Clark State.

For design purposes later in this study, it is necessary to calculate the percentage of ADT and directional split of existing traffic volume during each peak hour on each of the two streets, as shown below.

Hamilton Road—N/O Clark State

AM peak hour = 6.5% ADT, PM = 8.5% ADT
AM peak hour = 60% southbound, 40% northbound
PM peak hour = 60% northbound, 40% southbound

Clark State Road—E/O Hamilton

AM peak hour = 11% ADT, PM = 11% ADT
AM peak hour = 75% westbound, 25% eastbound
PM peak hour = 75% eastbound, 25% westbound

The existing 2004 intersection turning movement volumes and percentages as well as volumes on each leg are shown for the AM and PM peak hours in Figure (2).

3. DESIGN YEAR AND TRAFFIC FORECAST

The City is planning to secure the funding for construction of the improvement of Hamilton Road from south of Clark State to south of Johnstown Road in 2011 and begin the construction in 2012. To maintain a reasonable 20 year design life of this project, the City has agreed to use 2032 as the project design year for this study.

As the federally designated regional transportation planning agency for Central Ohio, the Mid-Ohio Regional Planning Commission (MORPC) was asked to provide future traffic projections for this project using their existing regional forecast models. These computer models are based on forecast future land usage in the vicinity of this proposed project in coordination with the City and reflect a 2030 horizon year.

The MORPC travel demand model used for this study was based on an analysis of projected future land uses and vehicle trip generation from these uses; projected future street network including number of lanes and average speeds; and calculated vehicle trips assigned to the shortest time/distance from trip origin to destination.

Figure (3) shows the Gahanna study area which most directly impacts travel on Hamilton Road. Based on traffic generated from within and outside of the study area, the model assigns expected ADT volumes for 2030 on the street network. This process is the standard, accepted method used to establish future design volumes for most major street improvement projects within central Ohio.

Hamilton / Clark State Intersection Traffic Volumes

Measured Sept. 2004

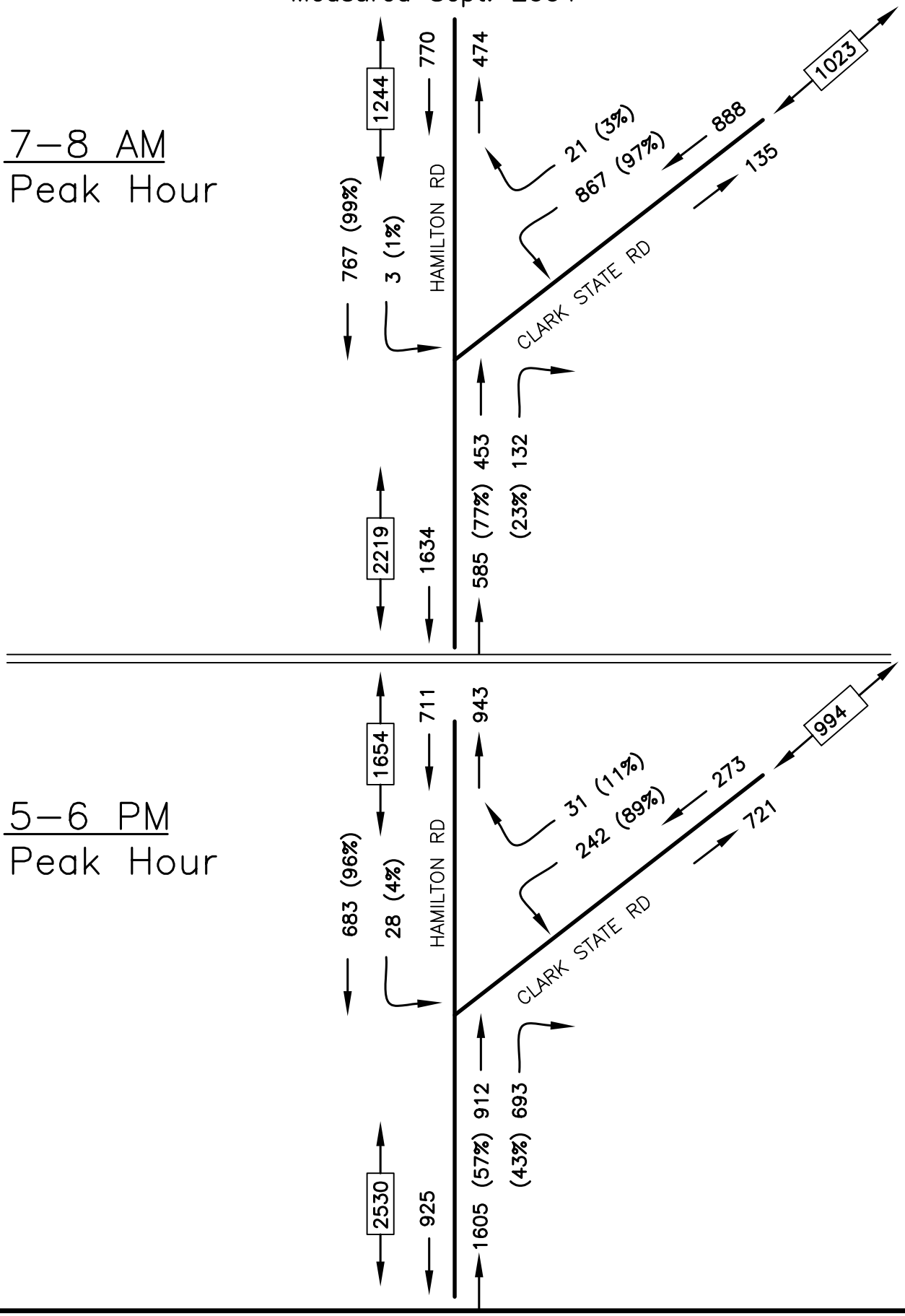


FIGURE 2

Gahanna Area TAZ's used in Demographic Forcast (highlighted)

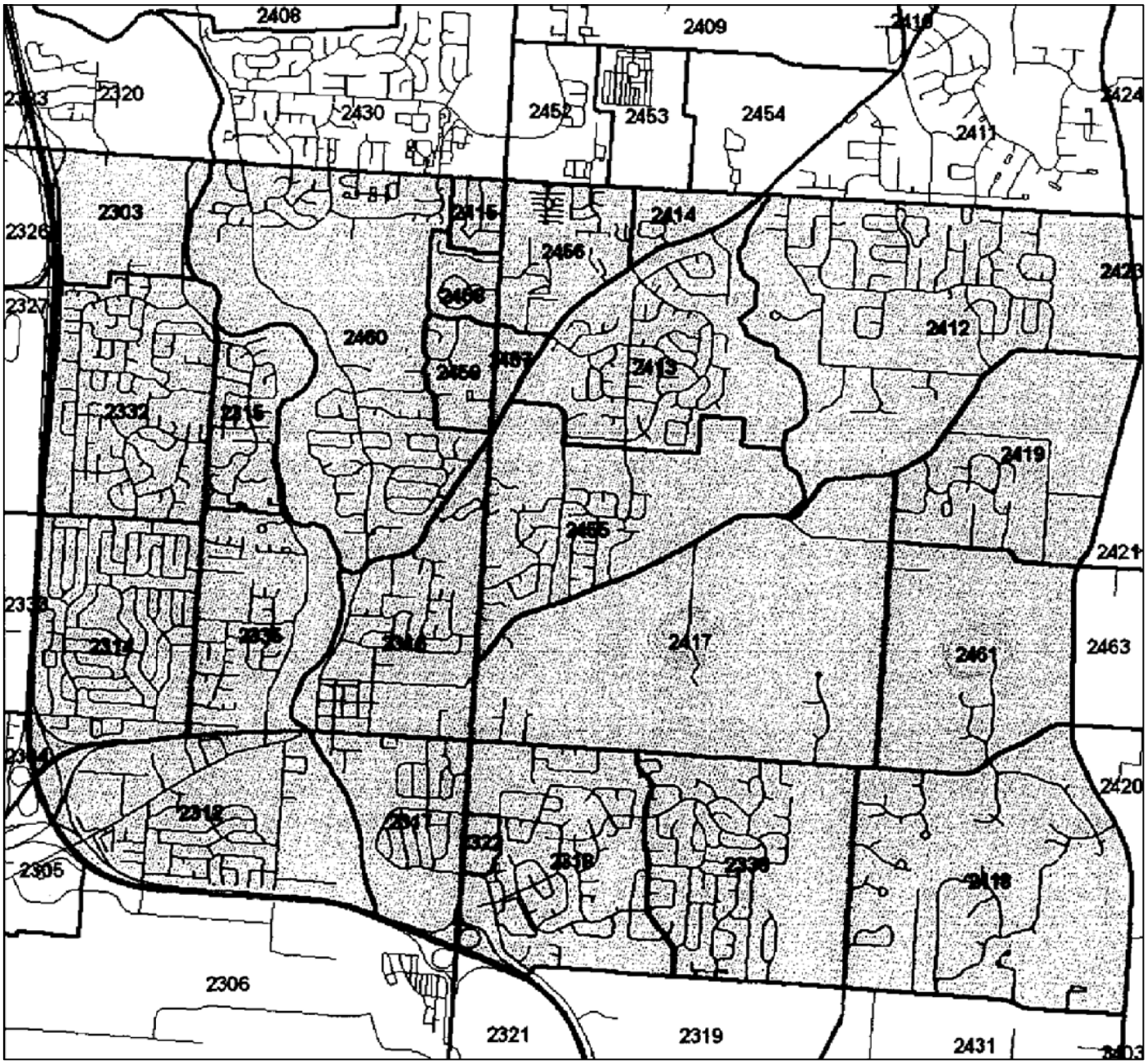


FIGURE 3

Part of the model forecasting analysis is to validate the model data against known existing traffic volume and land use information to assure the accuracy of the forecasted data. The first part of the validation process compared the model forecasted ADT for Hamilton Road for the year 2000 with actual measured ADT volumes for that year.

The actual ADT in 2000 was determined by analysis of six ADT counts of Hamilton Road between Clark State and Johnstown recorded between 1999 and 2004. Three of the counts were from MORPC files and three from a Gahanna count station. A regression analysis of these six counts determined the year 2000 ADT to be 10-11 percent higher than the model ADT. A comparison was also made between the model 2000 ADT and actual counted ADT's south of Clark State and north of Johnstown. Both of these comparisons showed the model is under-representing these actual ADT's.

Because the model is under-representing the year 2000 ADT's on Hamilton Road through the project area, it is concluded that the 2030 forecast ADT is under-represented to a similar degree. Therefore, the 2030 forecast ADT's were increased by 10% and are listed below:

- 3 lane case—2030 est. ADT = 27,500 vehicles per day.
- 5 lane case—2030 est. ADT = 32,700 vehicles per day.

The analysis sheets are included in the Appendix.

The estimated "vehicle demand" for travel on the subject link of Hamilton Road is represented by the 32,700 vpd for the five lane case. This is because the adjacent links of Hamilton Road to both the south and the north of the subject link were assumed to be 5 lanes wide in the travel demand model. In the 3 lane case, the model was constrained to only one through lane in each direction instead of two, resulting in approximately 5000 fewer daily vehicle trips using this link and being diverted to other network links to satisfy the overall demand for travel in the Hamilton Road corridor.

The second part of the validation process involved the City of Gahanna's review of the existing and future changes in land use densities used to generate the 2030 forecast ADT's. City staff review concluded that, although some of the 2030 land use densities should be increased, overall the land use projections were acceptable.

MORPC provided 2030 forecasted ADT volumes on Hamilton Road north of Clark State Road for two scenarios of possible improvements to Hamilton Road; three lanes (one each direction and a center two-way left-turn lane), and five lanes (two each direction and a center two-way left turn lane). These two forecast scenarios will provide appropriate ADT volumes for all of the following alternative street designs to be considered in this study:

1. Three lanes
2. Four lanes
3. Four lanes with added turn lanes
4. Five lanes
5. Four lanes with raised medians

These alternative designs will be described and analyzed later in this study. See Appendix for MORPC memos with the future forecasted land uses and ADT volumes.

4. LOCAL VS. THROUGH TRAFFIC

The City requested the study compare the amount of "local Gahanna area" traffic using this central section of Hamilton Road with the amount of "through" traffic from outside the local Gahanna area using the same section. The study investigated use of in-vehicle surveys or license plate surveys of traffic moving between Clark State Road and Johnstown Road. The likely high cost and disruption of traffic flow were considered too detrimental to allow use of these survey methods.

Instead it was decided to utilize the MORPC forecast model information to aggregate the origins and destinations of all vehicle trips using the Clark State to Johnstown link in the 2030 street network to determine the percentage of all trips with origins or destinations within or outside of the "local Gahanna area". Past studies have shown that this can provide an estimation of "local vs. non-local" vehicles using a given street link.

For purposes of this study the "Local Gahanna Area" was defined as being within the following boundaries: west--I-270; east-Taylor Station Road, Mann Road and Rocky Fork Creek; north—Morse Road, Broadview Road and Thompson Road; south—I-270 and CSX railroad. MORPC performed a "select link analysis" of forecasted ADT's to show the path of all vehicle trips to and from the selected link of Hamilton Road.

The forecasted number of daily vehicle trips using the link of Hamilton Rd. between Clark State and Johnstown was aggregated according to their origin and destination: (1) both origin and destination within the "Gahanna area"; (2) both origin and destination outside of the Gahanna area; and (3) either origin or destination within the area.

Comparison of the above trip data with the total number daily trips using Hamilton Rd. yields the following results:

- Approximately 70% to 75% of all trips have either one or both the origin and destination within the Gahanna area.
- Approximately 25% to 30% of all trips have both the origin and destination outside of the Gahanna area.

It can be concluded that the 2032 forecasted traffic volumes indicate a great majority of traffic on this Hamilton Rd. link is Gahanna-based "local" traffic and only a relatively small minority can be classed as "through" traffic.

This study, while based on projected future conditions in 2032, is a good indicator of existing traffic conditions on Hamilton Road. Summary sheets of this analysis can be found in the Appendix.

5. DETERMINATION OF DESIGN VOLUMES

A. Average Daily Traffic

To determine project design volumes for the three lane and five lane scenarios (to be used for all design alternatives), it is necessary to increase the MORPC 2030 forecast ADT's to the 2032 design year.

Applying MORPC's recommended 2% annual growth rate for both scenarios results in the following 2032 Design ADT's:

- 3 lane Hamilton—28,600 vpd.
- 5 lane Hamilton—34,000 vpd.

As discussed in Section 4, the 2032 ADT of 34,000 vpd also becomes the "true demand" for travel in the Hamilton Road corridor.

Assuming the east leg of Clark State Road has an equal traffic volume growth as Hamilton Road, the Clark State 2032 ADT can be estimated:

- Hamilton Road growth (5 lane) = $\frac{34{,}000 - 18{,}800}{18{,}800} = 81\%$
- Clark State 2032 ADT (5 lane Ham.) = 8670 + 8670 (0.81) = 15,700 vpd

To determine the design ADT for Clark State Road when Hamilton Road is three lanes, the MORPC forecast shows that a three lane Hamilton Road carries 5400 fewer vehicles per day than 5 lanes. Consultation with MORPC verified that the 5400 vpd is a "demand" for the Hamilton Road corridor which cannot be accommodated in a three lane scenario. Those 5400 daily vehicle trips will divert to other parallel routes in the Hamilton Road corridor. A reasonable assumption can be made that approximately half or 2700 of these vehicle trips will use Clark State Road because of the angled intersection and close-by Clotts Road

continuing parallel to Hamilton. The assumption is also made that most of the remaining 2700 trips per day will be using other convenient alternative routes to Hamilton Road such as Johnstown Road and Mill St. through Gahanna.

The diversion of 2700 daily vehicle trips to Clark State Road with a three lane Hamilton Road will result in the following design ADT:

- Clark State 2032 ADT (3 lane Ham.) = 15,700 + 2,700 = 18,400 vpd

B. Design Hourly Volumes at Hamilton/Clark State Intersection

The basis of determining the 2032 design hour volumes at the intersection of Hamilton and Clark State will be the 2004 turning movement count shown in Figure (2).

Considering the existing 2004 traffic volumes and the expected changes in land development and street infrastructure through 2032, the design hour relationships to ADT and directional splits are assumed to be consistent with existing except for the peak hour percentage of ADT on Clark State Road. This should drop from 11% to 10% in 2032.

The following design hour factors will be used in this study:

- Hamilton Road

  DHV (AM) = 6.5% ADT, PM = 8.5% ADT
  Directional split (AM) = 60% SB, PM = 60% NB

- Clark State Road

  DHV (AM) = 10% ADT, PM = 10% ADT
  Directional split (AM) = 75% WB, PM = 75% EB

To determine 2032 design hour turning movements at the intersection of Hamilton Road and Clark State, the existing peak hour turning movement counts are converted to percentages of each approach volume. The 2032 approach volumes are calculated by applying the above design hour factors to the design ADT's. The design turning movements are then determined by applying the turning movement percentages to the calculated approach volumes. This process is done for the AM and PM peak hours for both the three lane Hamilton and five lane Hamilton scenarios.

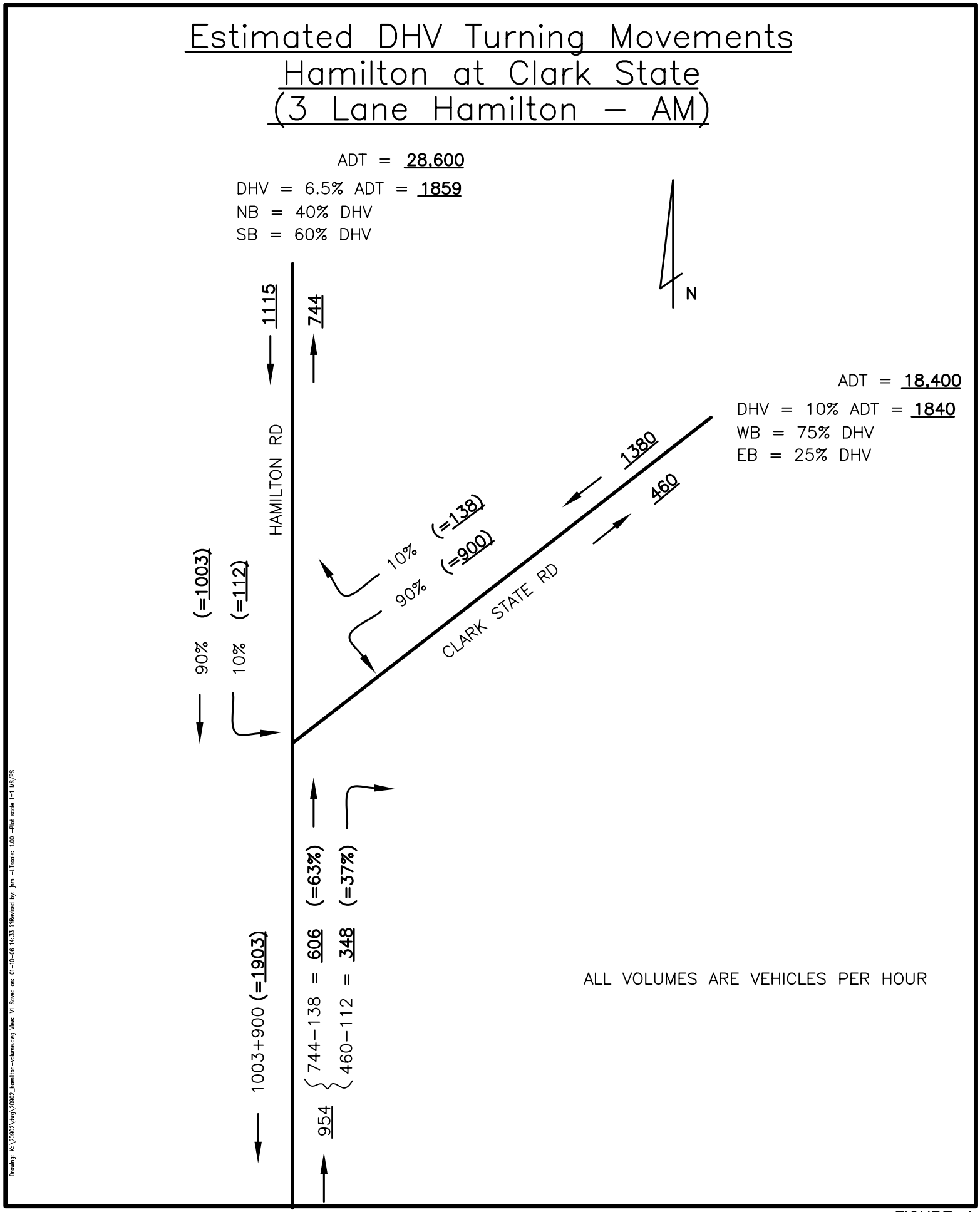
Due to the forecasted higher than average growth of the area east of Hamilton Road along Clark State Road through 2032, the percentage of peak hour turns between the east leg and the north leg of the intersection has been

increased to a minimum of ten percent. The PM westbound right turns will remain at 11% of the approach volumes.

The design hour traffic volume summary sheets are presented for a three lane Hamilton Road in Figure (4) for AM and Figure (5) for PM, and for a five lane Hamilton Road in Figure (6) for AM and Figure (7) for PM.

A summary of the resulting intersection 2032 design hour traffic movements is shown in Figure (8).

Estimated DHV Turning Movements
Hamilton at Clark State
(3 Lane Hamilton – AM)



Drawing: K:\20902\dwg\20902_hamilton-volume.dwg View: V1 Saved on: 01-10-06 14:33 ??Revised by: jim -LTscale: 1.00 -Plot scale 1=1 MS/PS

FIGURE 4

Estimated DHV Turning Movements
Hamilton at Clark State
(3 Lane Hamilton – PM)

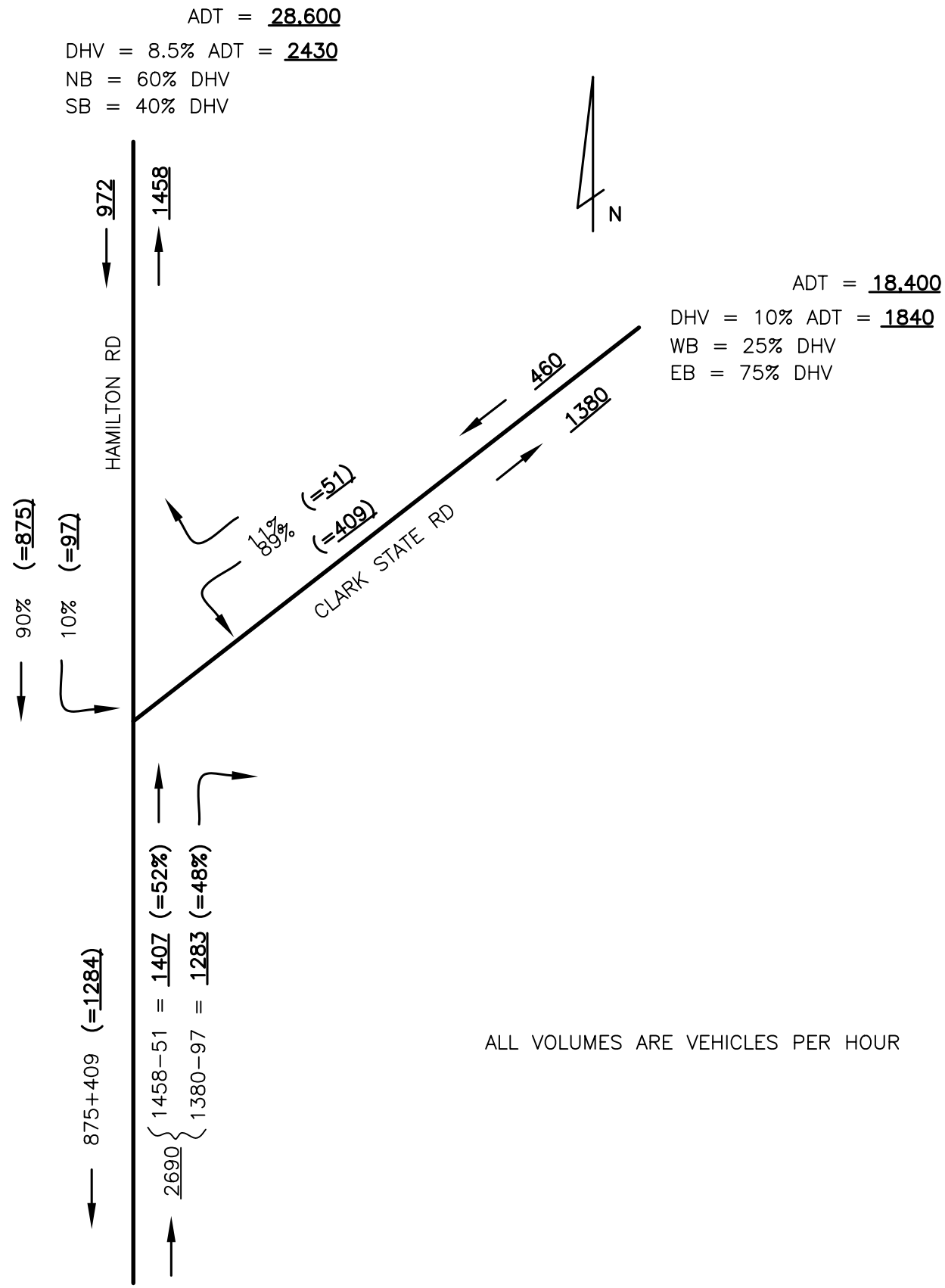


FIGURE 5

Estimated DHV Turning Movements
Hamilton at Clark State
(5 Lane Hamilton – AM)

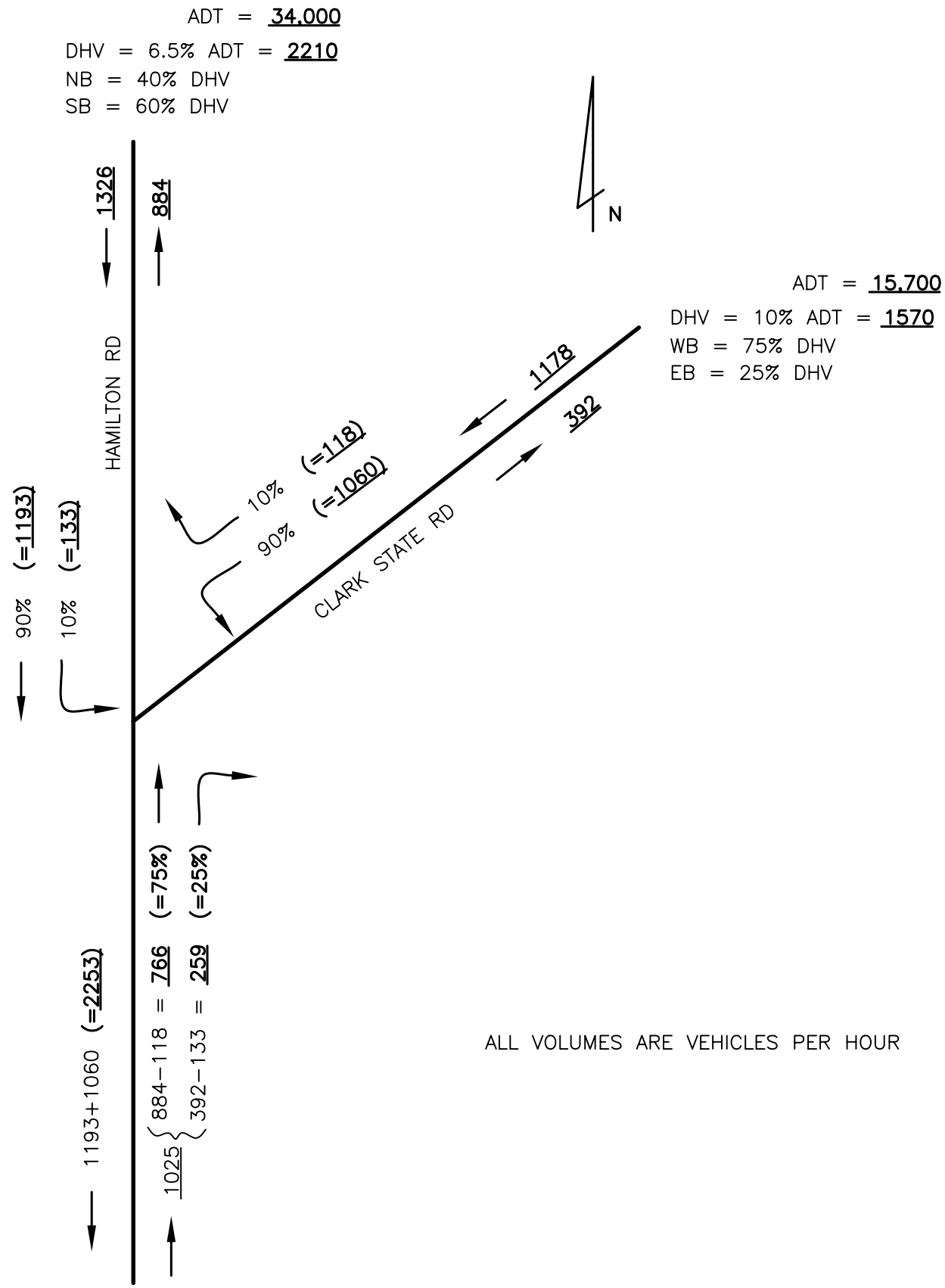


FIGURE 6

Estimated DHV Turning Movements
Hamilton at Clark State
(5 Lane Hamilton – PM)

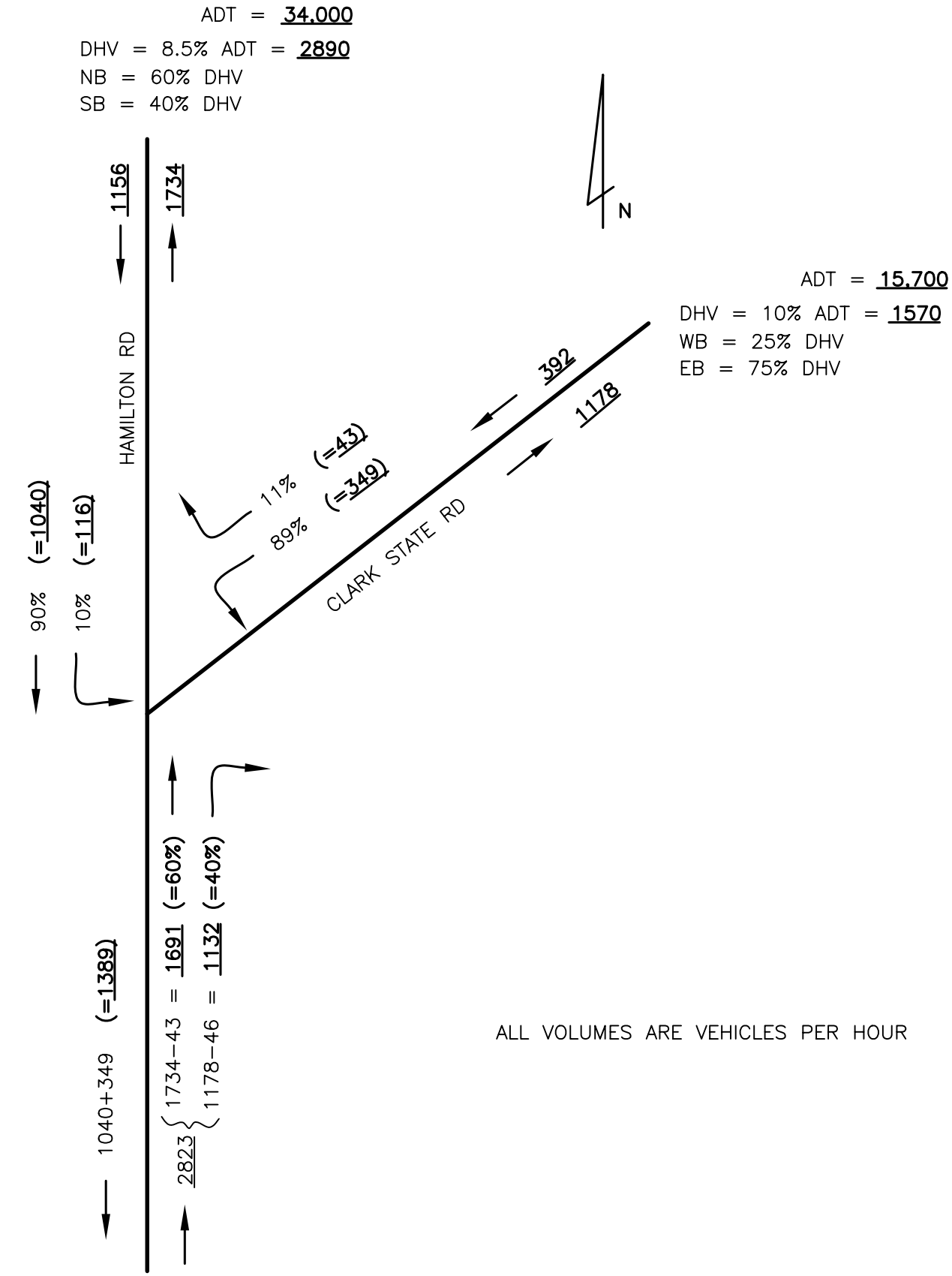


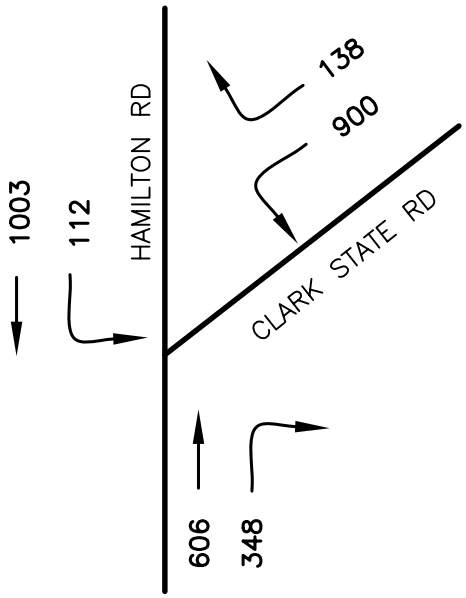
FIGURE 7

Intersection 2032 Design Hour Traffic Movements

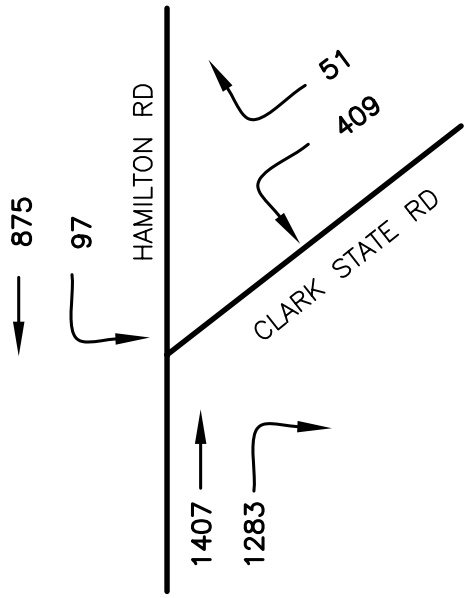
ALL VOLUMES ARE VEHICLES PER HOUR

Three Lane Hamilton Rd.

AM

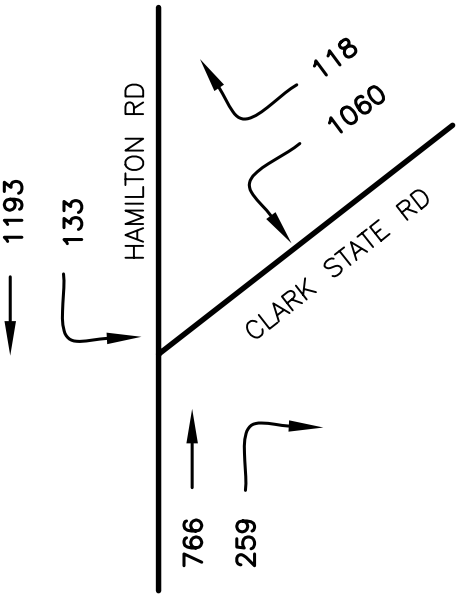


PM



Five Lane Hamilton Rd.

AM



PM

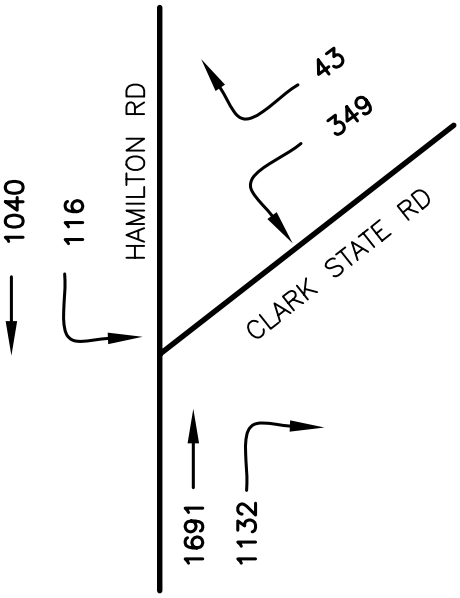


FIGURE 8

C. Design Hourly Volumes at All Side Streets

The 2032 design hour volumes calculated for the north leg of the Clark State intersection will be extended as the design hour "through" traffic volumes over the remainder of the study section north to the Johnstown Road intersection. These design hour volumes are listed below:

- 3 lane Hamilton

  AM-southbound = 1115 vph, northbound = 744 vph
  PM-southbound = 972 vph, northbound = 1458 vph

- 5 lane Hamilton

  AM-southbound = 1326 vph, northbound = 884 vph
  PM-southbound = 1156 vph, northbound = 1734 vph

For the analysis of intersections and driveways between Clark State and Johnstown Road, the estimated peak hour turning movements for 2032 will be added to the above through volumes. This method is appropriate since all of the intersecting turning volumes are relatively very small.

All but one of the intersecting side streets or drives serve fully built-out land developments which are assumed to remain relatively unchanged through 2032. Using this assumption the existing peak hour turning movements in and out of these locations have either been measured or will be estimated using the Institute of Transportation Engineers (ITE) publication "Trip Generation", 7th Edition, methods and appropriate land use categories. See the Appendix for calculation sheets.

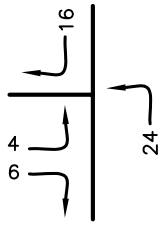
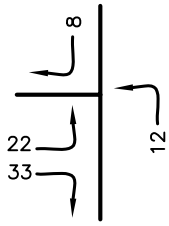
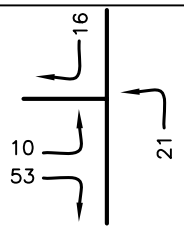
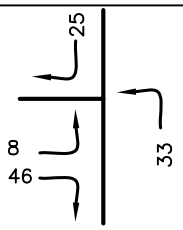
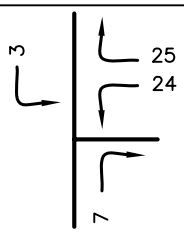
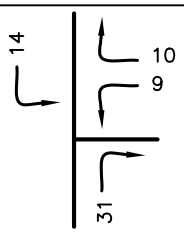
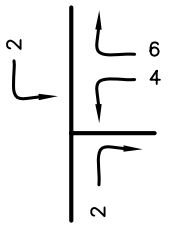
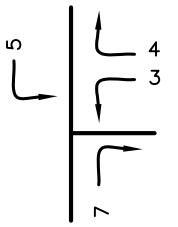
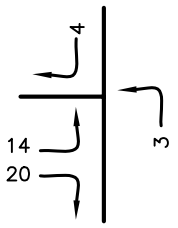
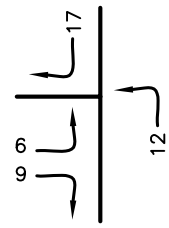
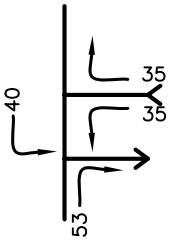
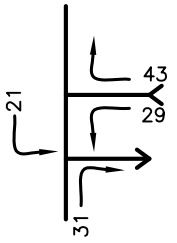
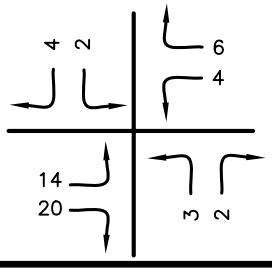
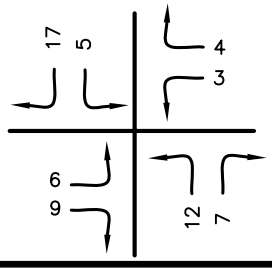
A summary of the thirteen (13) intersecting streets and major drives between Clark State and Johnstown illustrating the estimated existing peak hour side street volumes is shown in Figure (9). These 13 locations have been grouped into seven (7) groups with similar traffic turning movements.

An additional intersection of Carpenter Road south of Clark State was also studied for possible impacts. The 2032 design hour volumes were calculated for the south leg of the Hamilton and Clark State intersection for use in the study of this intersection. These design hour through volumes are listed below:

- 3 lane Hamilton

  AM southbound = 1903 vph, northbound = 954 vph
  PM southbound = 1284 vph, northbound = 2690 vph

Estimated/Measured Existing Peak Hour Side Street Volumes
Hamilton Rd. between Clark State and Johnstown

Side Street (Drive)	AM	PM
1. Office Building s/o Johnstown (estimate)		
2. Worman Dr. (count)		
3. Tresham Rd. (count)		
4. Cul-de-sac Sid Streets (5) Langford, Allenby, Medwin, Thorburn, Old Mill (estimate)		
5. Sycamore Woods Condo Access (count)		
6. School Drives (2) (count)		
7. Future Residential Access/Peale Ct. (2) (estimate)		

ALL VOLUMES ARE VEHICLES PER HOUR

FIGURE 9

- 5 lane Hamilton

  AM southbound = 2253 vph, northbound = 1025 vph
  PM southbound = 1389 vph, northbound = 2823 vph

The AM and PM turning movements to and from Carpenter were recently counted and are summarized below:

- AM turns into Carpenter: left-22, right-196
  AM turns from Carpenter: left-13, right-32
- PM turns into Carpenter: left-47, right-35
  PM turns from Carpenter: left-62, right-32

6. INTERSECTION CAPACITY ANALYSIS

A. Capacity Calculations

In order to compare the traffic operations of the proposed alternative improvements of Hamilton Road, a series of intersection capacity analyses were conducted utilizing the design hour volumes determined in the previous section.

The software used in the analysis of intersection capacity is "Synchro 6, build 614" and is based on the procedures detailed in the Highway Capacity Manual (HCM) published by the Transportation Research Board.

Level of Service (LOS) is the standard used to evaluate traffic operating conditions of the transportation system. This is an assessment of the quantitative effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays, and freedom to maneuver. Level of service is the measure of effectiveness for intersection operation. It is based on roadway system characteristics including lane geometry, percentage of trucks, peak hour factor, number of lanes, signal progression, traffic volume, ratio of signal green time to cycle time (G/C), roadway grades, parking conditions, and pedestrian flows. Levels of service categories have been established based on relative levels of driver acceptability of various delays. The following table summarizes LOS categories.

The overall intersection LOS is deemed most important for signalized intersections. In most urban areas, overall LOS ratings of A to D are normally considered acceptable for signalized intersections, levels C or better are considered desirable, and levels of service E and F are unacceptable.

Level of Service Criteria
Signalized Intersections

Level of Service	Average Stopping Delay per Vehicle (Sec)	Quantitive Description
A	≤ 10.0	Good progressions, few stops, and short cycle lengths (Acceptable Traffic Flow)
B	> 10.0 and ≤ 20.0	Good progression and/or short cycle lengths; more vehicle stops (Acceptable Traffic Flow)
C	> 20.0 and ≤ 35.0	Fair progression and/or longer cycle lengths; some cycle failures; significant portion of vehicles must stop (Acceptable Traffic Flow)
D	> 35.0 and ≤ 55.0	Congestion becomes noticeable; high volume-to capacity ratio, longer delays, noticeable cycle failures (Acceptable Traffic Flow)
E	> 55.0 and ≤ 80.0	At or beyond limit of acceptable delay; poor progression, long cycles, high volumes, long queues (Undesirable Traffic Flow)
F	> 80.0	Unacceptable to drivers. Arrival volumes greater than discharge capacity; long cycle lengths, unstable-unpredictable flows (Undesirable Traffic Flow)

The Level of Service criteria for unsignalized intersections are somewhat different from those of signalized intersections. For unsignalized intersections more emphasis is placed the delay of each minor movement. Also the delay threshold for any given level of service is less for an unsignalized intersection. This results from drivers expecting unsignalized intersections to have lower traffic volumes with fewer delays. Under these conditions drivers behave differently and are less patient.

Level of Service Criteria
Unsignalized Intersections

Level of Service	Delay Range (Sec)
A	≤ 10.0
B	> 10.0 and ≤15.0
C	> 15.0 and ≤ 25.0
D	> 25.0 and ≤ 35.0
E	> 35.0 and ≤ 50.0
F	>50.0

Level of Service F exists when there are insufficient gaps of a suitable size to allow side street demand to cross safely through a major street traffic stream.

Capacity analysis for this study was done in two stages; the first stage was the analysis of the signalized intersection at Clark State Road and the second stage was the analysis of the side street intersections. Since this is the only major signalized intersection within the project, the capacity analysis was

used to study the "No build" condition as well as to determine the number of approach lanes and operation of the signal to achieve a safe and efficient operation with a three lane and a five lane basic cross-section on Hamilton Road. These two basic cross-sections will be used to analyze all of the proposed design alternatives at this critical intersection.

This signalized intersection analysis will also include the determination of the required vehicle storage lengths of all approach lanes for each of the two basic Hamilton Road cross-sections.

The second stage capacity analysis was done at all of the thirteen (13) unsignalized intersections or drives to determine the safety and efficiency of traffic operations for a three, four and five lane basic cross-section for Hamilton Road These three basic cross-sections can be used to analyze any of the five proposed design alternatives for Hamilton Road.

7. CAPACITY RESULTS-CLARK STATE AT HAMILTON SIGNALIZED INTERSECTION

Figure (10) summarizes the capacity results of the 2032 AM and PM peak conditions assuming a "No build" or no changes in the existing physical conditions and also assuming Hamilton Road with three lane design conditions. Several iterations of adding intersection approach lanes were done until the capacity results indicated an "acceptable" and "desirable" operation LOS was achieved for the proposed AM and PM peak hour design conditions.

Figure (11) summarizes the capacity results assuming Hamilton Road with five lane design conditions for the AM and PM peak hours. Again, additional approach lanes were added until an "acceptable" LOS was achieved for the 2032 design conditions. See the Appendix for capacity calculation summary sheets.

Three Lane Alternative Capacity Results

If this intersection were not improved beyond what now exists, the projected 2032 peak hour volumes would cause unacceptable driver peak hour delays of over 2 minutes at a LOS "F".

If Hamilton Road were to be constructed as three lanes wide between Clark State and Johnstown, the following capacity results would apply to the Clark State intersection: In order for this intersection to operate at an "acceptable" LOS of "D" in both the AM and PM peak hours, an additional (second) northbound through lane and an additional (second) westbound left turn lane are required. This geometric design would permit noticeable congestion during the two week day 2032 peak periods with an average stopping delay per vehicle of 45.7 seconds in the AM and 43.9 seconds in the PM.

Capacity Summary of Results
2032 Peak Hours for Existing Geometrics and Three Lane Hamilton Road

Hamilton & Clark State

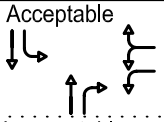
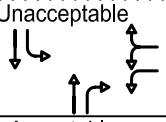
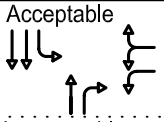
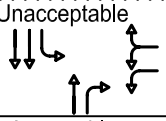
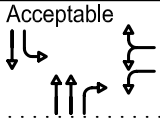
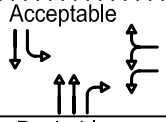
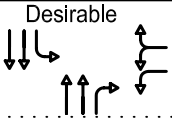
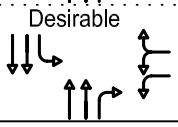
Scenario	Peak Hour	Geometrics	LOS / Delay	Results
2032 Design Existing Geometrics	AM	NB: 1 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT/RT	F / 146.6	Unacceptable
2032 Design Existing Geometrics	PM	NB: 1 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT/RT	F / 96.3	Unacceptable
2032 Design 3 Lanes Added WB Lanes	AM	NB: 1 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT, 1 RT	F / 110.7	Unacceptable
2032 Design 3 Lanes Added WB Lanes	PM	NB: 1 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT, 1 RT	F / 88.0	Unacceptable
2032 Design 3 Lanes Added NBTH and SBLT	AM	NB: 2 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT/RT	F / 140.1	Unacceptable
2032 Design 3 Lanes Added NBTH and SBLT	PM	NB: 2 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT/RT	D / 44.3	Acceptable
2032 Design 3 Lanes Added Double WBLT	AM	NB: 1 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT, 1 LT/RT	D / 47.8	Acceptable 
2032 Design 3 Lanes Added Double WBLT	PM	NB: 1 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT, 1 LT/RT	E / 62.0	Unacceptable 
2032 Design 3 Lanes Added SBTH and Double WBLT	AM	NB: 1 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 LT/RT	C / 29.1	Acceptable 
2032 Design 3 Lanes Added SBTH and Double WBLT	PM	NB: 1 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 LT/RT	E / 61.0	Unacceptable 
2032 Design 3 Lanes Added NBTH and Double WBLT	AM	NB: 2 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT, 1 LT/RT	D / 45.7	Acceptable 
2032 Design 3 Lanes Added NBTH and Double WBLT	PM	NB: 2 TH, 1 RT SB: 1 LT, 1 TH WB: 1 LT, 1 LT/RT	D / 43.9	Acceptable 
2032 Design 3 Lanes Added NB/SBTH and Double WBLT	AM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 LT/RT	C / 24.6	Desirable 
2032 Design 3 Lanes Added NB/SBTH and Double WBLT	PM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 LT/RT	C / 25.8	Desirable 

FIGURE 10

Capacity Summary of Results
2032 Peak Hours for Five Lane Hamilton Road

Hamilton & Clark State

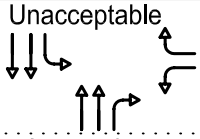
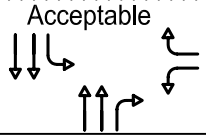
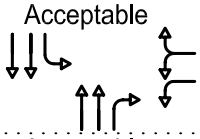
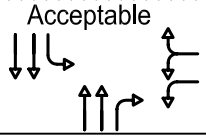
Scenario	Peak Hour	Geometrics	LOS / Delay	Results
2032 Design 5 Lanes Added NBTH, SBTH	AM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT/RT	F / 109.6	Unacceptable
2032 Design 5 Lanes Added NBTH, SBTH	PM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT/RT	C / 26.6	Acceptable
2032 Design 5 Lanes Added WBRT	AM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 RT	F / 82.1	Unacceptable 
2032 Design 5 Lanes Added WBRT	PM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 RT	C / 24.4	Acceptable 
2032 Design 5 Lanes Added WBLT	AM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 LT/RT	C / 30.5	Acceptable 
2032 Design 5 Lanes Added WBLT	PM	NB: 2 TH, 1 RT SB: 1 LT, 2 TH WB: 1 LT, 1 LT/RT	C / 22.5	Acceptable 

FIGURE 11

Figure (10) illustrates if fewer approach lanes than above are used in any combination, the intersection LOS will only reach unacceptable LOS "E" or "F" with long average stopping delays.

A more "desirable" capacity operation could be provided during daily peak periods by the addition of a second southbound through lane. This would raise the LOS to "C" with average delays of 25 to 26 seconds per vehicle during the two daily peak periods.

Five Lane Alternative Capacity Results

If Hamilton Road between Clark St. and Johnstown were to be constructed with two through lanes in each direction, the Clark State intersection would have the following capacity results: With only two through lanes northbound and southbound and added southbound left turn lane and westbound right turn lane, the intersection still operates at an "F" LOS during morning peak periods. In order to operate at an "acceptable/desirable" LOS "C" in both peak periods, an additional westbound left turn lane is required. The average stopping delay would be reduced to a more desirable 23 and 31 seconds per vehicle.

Clark State at Hamilton Capacity Conclusions

Based on the preceding intersection capacity analysis it is concluded that the following intersection designs are the most feasible for each of the two design alternatives:

- 3 Lane Hamilton—approach lanes (LOS "D")

Northbound	Southbound	Westbound
2 thru lanes	1 thru lane	1 left turn lane
1 right turn lane	1 left turn lane	1 left+right turn lane

- 5 Lane Hamilton—approach lanes (LOS "C")

Northbound	Southbound	Westbound
2 thru lanes	2 thru lanes	1 left turn lane
1 right turn lane	1 left turn lane	1 left+right turn lane

The above intersection designs are the result of an iterative process of adding more approach lanes on each capacity test until the minimum number of lanes is reached which results in an "acceptable" LOS as defined by the Federal Highway Capacity Manual.

The three lane intersection design of Clark State and Hamilton will be included in the overall feasibility study of the "three lane street design alternative" listed earlier in this report. The five lane intersection design will be included in the study of the remaining design alternatives which all have two through lanes in each direction.

Clark State at Hamilton Storage Lane Lengths

To conduct a conceptual design of this intersection and analyze the various alternative street designs, it is necessary to calculate the required length of vehicle storage on the intersection approaches. These required lengths were calculated using the method in the Ohio Department of Transportation (ODOT) Location and Design Manual, Vol. 1, Figures 401-5, 401-7 and 401-8 for year 2032 design volumes.

The resulting required storage lengths will be incorporated into the alternative street designs. A summary of storage lengths is in the Appendix.

8. CAPACITY RESULTS—SIDE STREET INTERSECTIONS

To assist in evaluating the alternative street designs, it was necessary to analyze the capacities of all unsignalized intersecting side streets and major driveways within the project area. A total of thirteen (13) stop controlled side street locations were studied under three street alternatives: three lane Hamilton (with center two-way left turn lane), five lane Hamilton (with center two-way left turn lane) and four lane Hamilton (with no left turn lane). The results of these three analyses can be used to analyze the remaining two design alternatives (four lane Hamilton with raised median and four lane Hamilton with added left turn lanes at some locations).

Figure (12) summarizes and compares the capacity results for the 2032 design year AM and PM peak hours for the three lane, five lane and four lane alternatives.

For each side street location, the figure lists the peak hour LOS on the minor street, the average seconds of delay to all vehicles approaching Hamilton Road and the maximum queue length in increments of 25 feet (one vehicle) of stopped vehicles on the minor street.

An evaluation of the side street capacity results was made which resulted in highlighting the best operating condition of the three design alternatives for side street delay and for maximum vehicle queue length.

The four-lane alternative performed the worst of the three alternatives with the calculated delays all being greater than for the three-lane and five-lane

Side Street Capacity Comparisons of Design Alternatives

Location	Peak Hour	4 Lane Alternative			3 Lane Alternative			5 Lane Alternative		
		LOS	*Delay*	*Queue*	*LOS*	*Delay*	*Queue*	*LOS*	*Delay*	*Queue*
Office Building	AM	E	43.4	25	F	50.7	25	C	**22.0**	25
	PM	F	267.1	125	F	*	*	D	**25.9**	25
Old Mill	AM	D	27.6	25	D	28.9	25	C	**16.3**	25
	PM	F	159.8	25	F	84.5	25	D	**32.7**	25
Thoburn	AM	D	27.6	25	C	19.1	25	C	**16.3**	25
	PM	F	96.6	25	E	35.4	25	D	**32.7**	25
Sycamore Woods	AM	E	45.5	25	C	24.5	25	C	**22.5**	25
	PM	F	59.9	25	D	26.6	25	C	**21.3**	25
Medwin	AM	D	27.6	25	C	19.1	25	C	**16.3**	25
	PM	F	96.6	25	E	35.4	25	D	**32.7**	25
School Exit	AM	F	38.4	50	C	21.5	25	C	**17.8**	25
	PM	F	238.2	100	E	45.7	50	E	**41.3**	25
Future Drive/ Peale	AM	F	71.0	50	D	27.3	25	D	**26.7**	25
	PM	F	100.7	25	D	33.0	25	D	**25.1**	25
Tresham	AM	E	42.9	50	C	23.5	25	C	**19.4**	25
	PM	F	169.4	50	E	40.3	25	E	**38.5**	25
Langford	AM	D	27.6	25	C	19.1	25	C	**16.3**	25
	PM	F	96.6	25	E	35.4	25	D	**32.7**	25
Allenby	AM	D	28.3	25	C	21.4	25	B	**14.9**	25
	PM	F	718.0	50	F	141.5	25	E	**44.6**	25
Worman	AM	E	42.1	50	D	31.0	50	C	**21.0**	25
	PM	F	288.3	150	F	52.3	50	C	**18.5**	25
Carpenter	AM	F	*	*	F	342.7	125	F	*	*
	PM	F	*	*	F	*	*	F	*	*

FIGURE 12

xx.x = Best operating conditions of the three alternative designs.
* = Unable to calculate the extremely high delay and queue.

designs. Also, the LOS was calculated at "F" for 15 of 24 peak hour locations studied.

The five-lane alternative performed the best of the three alternatives with the lowest side street delays in 22 of the 24 peak hours. The LOS results were the best of the three alternatives for 12 of 24 hours studied and equal to the three-lane results in 12 additional peak hours.

The five lane alternative has only four side streets operating at an unacceptable LOS E or F during at least one peak hour, as compared with all twelve side streets in the four lane alternative and ten of twelve side streets in the three lane alternative.

In summary, the five lane alternative design performs better than the three lane or four lane alternative in terms of operating LOS, side street delay and maximum side street queuing.

In comparison to the four lane with added turning lanes alternative, the intersections of Office Building, Sycamore Woods, School Exit, Future Drive at Peale, Tresham and Worman have the same better results as the five lane alternative. However, the remaining locations have the same worse results as the four lane alternative. The result is the five lane alternative will perform better than the four lane with added turn lanes alternative.

In comparison to the four lane with median alternative, because of the location of the proposed median left turn lanes, this design alternative will perform identical to the five lane design alternative except for individual driveway access.

In regards to the operation of the intersection of Carpenter Road south of Clark State, all capacity analyses resulted in very high levels of congestion and delay in both AM and PM peaks due to the close proximity to the Clark State signalized intersection.

Side Street Intersections—Capacity Conclusions

The higher forecast PM peak period traffic volumes along Hamilton Road will cause higher levels of congestion and lower capacity performance at all side street intersections than will the AM peak period volumes.

The five lane design alternative and the four lane with median alternative will perform at much more acceptable levels of service and intersection delay than will the other three possible alternative designs.

Two potential capacity problem areas are at the school exit drive in the PM peak and at the Future Residential Drive at Peale Court If safety and/or

congestion become a problem in the future at the school drive during the normally short duration peak exiting period, law enforcement officer control or use of a short-term traffic control device may be considered. At the Future Residential Drive at Peale Court, the installation of a traffic signal may be considered in the future. The signal may also help create gaps in northbound Hamilton Road which would help the school drive 400 feet to the north.

The intersection of Carpenter Road will become highly congested and unsafe in the future under any of the design alternatives. Since signalization of this intersection appears not to be feasible, it is recommended to modify this intersection to prohibit eastbound left turns as a part of all the design alternatives.

9. MERGING TRAFFIC ANALYSIS

In the study of the three lane Hamilton Road alternative design, an additional operational factor must be analyzed. The merging of two lanes of through traffic to one lane as traffic enters both ends of this three lane section will cause some impacts on traffic operations in the areas north of Clark State and south of Johnstown.

A search revealed no specific models are available to study merging lanes on arterial streets. The Ohio Manual of Traffic Control Devices (OMUTCD) and the ODOT Location and Design Manual do provide guidelines and standards which will be used to analyze these two merging areas.

The southbound merge area south of Johnstown Road is now under construction and provides a total distance of 750' from the south edge of the Johnstown Road intersection to the south end of the project. In order to limit the proposed width of construction to three lanes in the study area, the merge analysis will assume that southbound traffic must be merged into one lane at the end of the present construction area.

Because this merge is immediately downstream from the signalized intersection, the peak southbound merging will occur during an assumed 120 second signal cycle in the peak volume hour (AM with a DHV of 1115 vph). Because the outside lane must merge, assume 40% (446 vph) in the outside lane merges with 60% (669 vph) in the inside lane. With 30 cycles per hour the merging volumes become 15 vehicles per cycle merging into 22 vehicles per cycle. From the OMUTCD, a minimum safe distance must include a "perception/reaction" distance, a queuing distance for merging vehicles to stop and a taper distance from two to one lane.

- Perception/reaction dist. at 40 MPH = 475'
- Queuing dist. for 15 vehicles = 375'
- Taper dist. for 12' lane = 320'
- Estimated safe merge distance = 1170'

Since the available distance of 750' falls considerably short of the estimated (without extending extra widening into the proposed three lane area), some negative impacts on traffic operations seem very likely during peak traffic periods. These include rapid slowing, stopping and accelerating in the merge area, the possibility of stopped vehicles extending back through the Johnstown Road intersection, and interference with intersecting traffic movements at driveways. All of these are potential safety problems.

Even if the merging area were extended south into the "three lane design alternative" area, not all of the negative impacts would be eliminated. There would still be slowing, stopping and accelerating in the merge area and the interference with driveway traffic would be extended to include Old Mill Drive.

The northbound merge area north of Clark State Road would all fall within the proposed project construction area, and therefore it is assumed that a minimum safe merging distance is provided. Because this merge is immediately downstream from the signalized Clark State intersection, the peak northbound merging will occur during an assumed 120 second signal cycle in the peak volume hour (PM with a DHV of 1458 vph). Using the same criteria as used at Johnstown Road the minimum safe merging distance can be estimated.

- Perception/reaction distance = 475'
- Queuing distance for 19 vehicles = 475'
- Taper distance for 11' lane = 300'
- Estimated safe merging distance = 1250'

The resulting northbound merge area would start at the north edge of the Clark State intersection and extend to just south of Langford Court. The maximum negative impacts of this merge will occur during weekday morning peak hours. These will include rapid slowing, stopping and accelerating of northbound vehicles and interference with traffic from the abutting driveways as well as the intersections of Worman Drive and Allanby Court.

It is concluded that the three lane Hamilton Road design alternative will have specific merging traffic negative impacts at both north and south ends of the project. These impacts will involve traffic flow as well as safety, and they will range from moderate to severe during the daily peak traffic periods.

10. DESCRIPTION OF FIVE ALTERNATIVE DESIGNS

At the beginning of this study, it was agreed with the City that the following five alternative street designs would be included in this feasibility study: three lanes, four lanes, five lanes, four lanes with added turn lanes, and four lanes with landscaped medians. It was also agreed to utilize eleven (11) foot wide through lanes and ten (10) foot wide turning lanes in the designs and to follow basic City geometric design standards.

Figure (13) illustrates the typical street cross-sections on Hamilton Road for all design alternatives between the major intersections of Clark State and Johnstown showing dimensions of all proposed lanes, curb and gutters, drainage ditch lines, sidewalks leisure trails and minimum widths of public right-of-way.

Both a curbed and uncurbed type of street are shown because that decision will be made later in the project design process. If open drainage construction is used, the width of public right-of-way will vary with the drainage requirements.

Although street lighting and landscaping are being planned as part of this improvement, they are not shown on these typical cross-sections. Also not shown is an appropriate degree of landscaping for all alternative designs in keeping with the residential character of the abutting community.

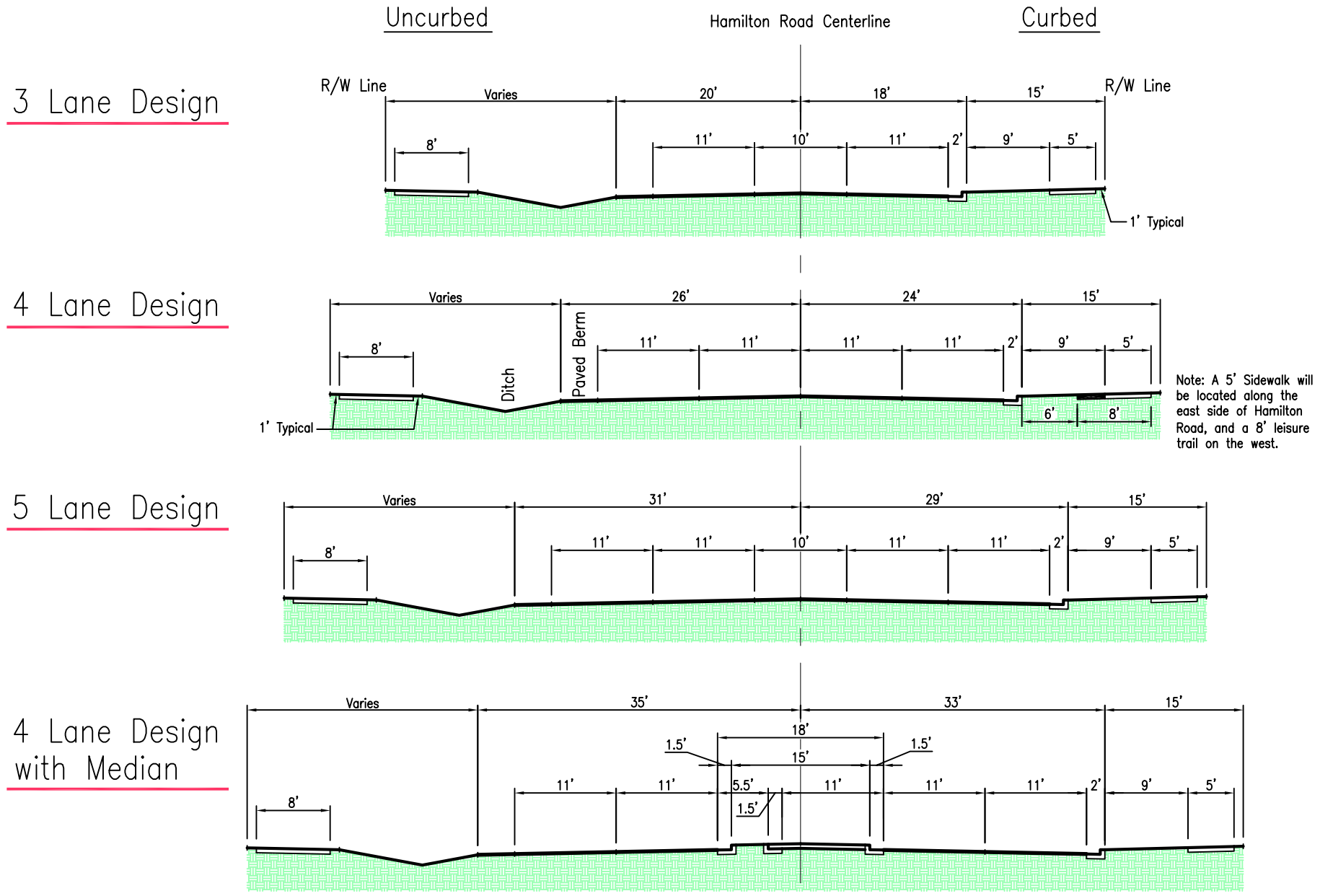
Concept drawings were prepared of the alternative street designs based on the above typical cross-sections and the conclusions of the capacity analysis at the Clark State-Hamilton intersection and merging analyses. A curbed type of pavement is shown for all design alternatives in order to better compare the alternatives.

The four alternative design concept drawings are attached to the back of this report. It should be noted that these drawings are not design drawings, but are done to assist in the selection of the most feasible design alternative.

One of the alternative designs is not shown as a separate drawing because it is a variation of the “four lane” and “five lane” alternatives. The description of this alternative is basically the four lane alternative with six added left turn lanes serving the six “critical” intersections with the largest number of left turn movements in the center of Hamilton Road. They are Worman Drive, Tresham Road, Future Residential Drive, School South Drive, Sycamore Woods Drive and Office Building Drive.

Preliminary analysis of this alternative revealed that each left turn lane would result in the four lane cross-section being widened to five lanes and tapered back to four lanes. While this would create a safer separate left turn lane, it would require the vast majority of Hamilton Road traffic to taper out and back approximately 10 times in each direction while traversing this section. All of

Hamilton Rd. Typical Cross-Sections For Each Design Alternative*



*The four-lane with some added turn lanes design is not shown but is discussed in the text.

FIGURE 13

these closely spaced lateral movements are non-standard, unexpected and a potential safety problem to through traffic. Further, left turns into the private drives and remaining five public streets without any protected left turn storage, may become more hazardous by being interspersed between protected left turn areas. In this respect, it is concluded that this alternative is the most unsafe of the alternatives. In comparison to the five lane alternative, this alternative would require approximately 70 percent of its length to be widened beyond four lanes while providing none of the safety and operating convenience of a continuous two-way left turn design as in the five-lane alternative.

In conclusion the "four lane with added left turn lane" design alternative offers no advantages over the "four lane" or "five lane" alternative and thus no concept drawing will be prepared for this alternative.

In preparing the concept drawings of the four remaining design alternatives, the existing centerline of Hamilton Road was used except in two areas:

- The City identified an approximate 1000 foot frontage on the west side of Hamilton opposite Peale Court which is assumed to be developed residentially before 2011. This development will result in the construction of pavement widening with a relocated curb and gutter west pavement edge approximately 26 feet west of the existing centerline. It is assumed that this relocated curb and gutter will continue to be used with all of the design alternatives for this project.

- The City identified a center point between the two closest houses to place the new project centerline for all design alternatives in the area from Sycamore Woods Drive to Old Mill Drive. This will help equalize any project impacts on both sides of the street and place the physical improvements more centered within available right-of-way.

The concept drawings utilized these guidelines and placed straight tapered areas connecting between areas of relocated center lines.

All four conceptual alternative street designs shown in the large drawings were prepared from a combination of analysis of the signalized intersection of Hamilton and Clark State and the analysis of Hamilton Road between Clark State and Johnstown.

11. COMPUTER SIMULATION OF ALTERNATIVE DESIGNS

Synchro is a complete software package for modeling traffic flow and optimizing traffic signal timings.

Synchro uses the methods of the 2000 Highway Capacity Manual, Chapters 15, 16, and 17; Urban Streets, Signalized Intersections, and Unsignalized Intersections. Synchro provides single intersection capacity analysis and timing optimization. Synchro can analyze networks of intersections and the effects of coordination. For example, a large queue at one intersection will spill back to the next neighboring intersection, which will impact intersection performance.

SimTraffic is a companion product to Synchro. SimTraffic performs micro simulation and animation of vehicle traffic. With SimTraffic, individual vehicles are modeled and displayed traversing a street network including signalized and unsignalized intersections.

This study includes the visual presentation of the simulation and animation of estimated 2032 peak hour traffic volumes. This presentation can provide decision makers and the public with a more realistic understanding of the future peak hour traffic movements and queuing passing through the Clark State Rd. and Carpenter Rd. intersections.

12. FEASIBILITY RANKING OF ALTERNATIVE DESIGNS

Based on the preceding study information and analysis, the five possible design alternatives for the improvement of Hamilton Road are ranked as to how well each alternative addresses or causes the least impact on each of the following project evaluation factors through the project design year of 2032. See Figure 14 for rankings.

- Safety

  This factor includes the evaluation of traffic safety of all vehicles, bicycles and pedestrians using each alternative design. There is a direct connection between traffic accident problems and high levels of vehicle congestion, changes of vehicle directions or speeds and conflicts between vehicles, bicycles and pedestrians.

- Operation

  This factor is used to evaluate the traffic operations of each alternative including the number of lanes on Hamilton Road; intersection Level of Service (LOS), average delay per vehicle and maximum vehicle queuing at Clark State Road and all side street intersections; merging maneuvers from two to one lane; and any diverted traffic.

Ranking of Design Alternatives

Project Evaluation Factors	Design Alternatives				
	3 Lane	***4 Lane***	***4 Lane + LT's***	***5 Lane***	***4 Lane + Median***
Safety	5	3	4	1	2
Operation	5	4	3	1	2
Construction Costs and R/W	1	2	3	4	5
Service to all Users	5	3	4	1	2
Impact on Abutting Properties	1	3	4	2	5
Maintenance	3	4	5	1	2
Useful Life of Project	4	3	5	1	2
Impact on Community	5	3	4	1	2
Total Score	29	25	32	12	22
Overall Ranking	**4**	**3**	**5**	**1**	**2**

FIGURE 14

- Construction Costs and Public Right-of-Way

  This factor includes the relative cost of design, construction, and required right-of-way for each of the alternative project designs and is generally proportional to the average total width of improvements.

- Service to All Users

  Users of this arterial street section include abutting residences, adjacent neighborhoods, pedestrians and cyclists, emergency services, Gahanna businesses and schools, trucks, buses and through traffic. The degree of service provided relates to accessibility to the street and the safety and operational characteristics of movement along the street.

- Impact on Abutting Property

  This factor includes the impacts of actual project construction on all properties abutting Hamilton or Clark State as well as long term impacts of accessibility and proximity to the streets.

- Maintenance

  This factor includes the expected level of all forms of public maintenance such as pavement, drainage, traffic control, enforcement and landscaping.

- Useful Life of Project

  This factor estimates the relative length of time into the future that each alternative roadway design will serve the public before requiring major reconstruction or improvement.

- Impact on Surrounding Community

  The overall impact of this project on the surrounding community relates to how well each alternative will serve the demands placed on it in terms of capacity and safety. High levels of congestion and/or operational safety problems in this section of Hamilton Road will likely result in traffic diverting to other available city streets and also impact emergency service response in the surrounding community. This factor estimates the relative likelihood of this condition for each alternative.

13. RECOMMENDED DESIGN

As a result of the ranking in Figure 14 and all of the preceding detailed study, it is recommended this project proceed following the “Most Feasible” alternative design: Five Lane Hamilton Road.